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THE MEASSUREMENT OF THE EQUILIBRIUM REAL EXCHANGE RATE. A NEW ECONOMETRIC APPROXIMATION

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Abstract

To determine the deviation of the real exchange rate (RER) with respect to some equilibrium level is of great importance for economic policy. However, the measurement of the RER as well as the determination of its equilibrium level are controversial matters.
In this work we present the two main approaches in the literature of the Equilibrium Exchange Rate: the Purchasing Power Parity hypothesis and the theory of the “fundamentals”.
In this paper, we propose a VECM methodology for the determination of the equilibrium RER in the framework of the "fundamentals" approach. Then, we suggest a methodology (a "rolling" VECM estimation) to check the stability of the parameters that at the same time improves on the VECM estimation.
Finally, we suggest proposals to improve the theory of “fundamentals” giving greater weight to the dis-equilibriums in the labor market.

JEL Classification number: C3, C5, E3, F3, F4

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THE MESUREMENT OF THE EQUILIBRIUM RER: A NEW ECONOMETRIC APROXIMATION

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> *"If on the other hand these assumptions are not fulfilled and changes are taking place in the "equation of exchange", as economist call it, between the services and products of one country and those of another, either on account of movements of capital, or reparation payments, or changes in the relative efficiency of labour, or changes in the urgency of the world' demand for that country's special products, or the like, then the equilibrium point between purchasing power parity and the rate of exchange rate may be modified permanently" Keynes (1923).*

For an economy that is undergoing a process of integration to the world markets the real exchange rate (RER) is very important, not only because it is an indicator of the external competitiveness of the economy, but also because it affects the performance of key macroeconomic variables and because it determines the sectorial composition of internal production and the allocation and use of productive factors. For Razin et al (1997) the RER misalignment also affects economic growth through three channels: 1) it has important effects on aggregate and sectorial investment domestic as well as foreign, 2) it determines the external competitiveness which in turn affects growth and, lastly, 3) the volatility of the RER has a negative effect on investment and trade.

In the case of Argentina, in the last years it is common to associate the appreciation of the RER with: the massive inflow of foreign capitals, the increase in the trade deficit, the growth in productivity and the substitution of labor for capital, the affectivity of the initial stabilization shock of the convertibility (currency board), the reduction in the competitiveness of a wide range of industrial sectors and the increase in the production of non-tradable goods, amongst other factors.

However, being the RER such an important variable for economic policy, its measurement is not exempt of ambiguity. In the first place there exist multiple ways of calculating the RER as the relative price between two baskets of goods (Obstfeld and Rogoff, 1997). The most widely accepted one is that of the quotient between the price of tradable goods and the price of non-tradable goods (Edwards, 1989); as an alternative, there exists an ample variety that compares the price of homogenous baskets of goods in one countries against another or others.

But to analyze the RER gives us little information if we lack some point of reference to compare with it. Thus we need to distinguish between the observed RER and the equilibrium or "natural" RER. Being the concept of equilibrium so difficult to model in economics, defining the equilibrium RER is not exempt of discrepancies. Simplifying, there exist to antagonistic views on how to measure the deviations with respect to the equilibrium. The most traditional and accepted is the one based on the Purchasing Power Parity (PPP) theory that, in a way, is to the theory of international monetary economics what the quantitative equation is to the monetary economics. On the other hand, the most recent concept for the measurement of the deviations of the RER is that which states that the observed RER must be compared with a RER that takes into account the sustainable internal and external equilibrium of the economy (Keynes, 1923, Edwards, 1989, Repetto, 1992). This view observes the effects of the fundamental variables in the determination of the equilibrium that could have suffered relevant structural changes. For example, in the last twenty years the Argentinean economy has suffered changes in its terms of trade, in its capital flows, in its degree of monetization, in its productivity, in its inflationary regime, in its degree of trade openness, in the importance of the State, etc. The idea of this view is that, in contrast with that of the PPP theory, a certain RER at time t could be depreciated or appreciated but not with respect to a state

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of equilibrium in the past but with respect to an “ideal” state of internal and external equilibrium corresponding with this moment t . At the same time, it is claimed that only real variables determine the RER in the long run (Edwards, 1989). For the PPP theory the RER is a monetary phenomena that confronted with real shocks could suffer changes but in the medium run is sorted out in the monetary sphere and, thus, the real determinants should not change the reference point.
Since the presence of deviations of the RER with respect to its equilibrium path could be problematic for the design of economic policies, finding an adequate analytical framework contributes to clarify the issue, and this is the main objective of this paper.
This study is organized as follows. First, we go over the multiple definitions of the RER and we analyze the degree of divergence for the case of Argentina, using quarterly data for the period 1980-1997. In section two we compare the evolution of the bilateral version against the US dollar and a multilateral version (weighted by trade). In section three we make a theoretical approximation at the idea of the equilibrium RER according to the two contrasting paradigms: the PPP theory and the Fundamentals framework. In sections four and five we develop the Fundamentals approach to determine the equilibrium RER. In the first place, we analyze the variables chosen as fundamental according to the literature in this field of research, and then we move on with the econometric estimation. In particular, we discuss an issue that in our opinion is crucial: the endogeneity in the determination of the RER with respect to its fundamentals. For that reason, we use the Vector Autoregression (VAR) methodology initiated by Sims (1980), instead of a uni-equational model with exogenous variables. Specifically, in the analysis of cointegration we find long run relationships that indicate that we should use a vector autorregresive model with an error correction mechanism (VECM) following Johansen (1998). We begin with a general model and through a process of selection of the relevant variables we reach a more parsimonious model. Here we also analyze the stability characteristics of the parameters of the VECM and design an alternative methodology of estimation of the equilibrium RER, the Rolling VECM (RVECM) which takes into account the possible changes in the values of the estimated coefficients in time. In section seven we study the deviations of the observed RER with respect to the sustainable equilibrium values. In the last section we present a comparison of the results from the PPP and the Fundamentals approach. We also present an explanation for the discrepancies and highlight possible extensions to improve the concept of equilibrium (especially, internal) in the models used as reference.

1. The Equilibrium Real Exchange Rate. Alternatives.

1.1 The PPP Theory

In the literature we can essentially find two different perspectives with respect to the determination of the long run or equilibrium real exchange rate.
Firstly, the so-called Theory of the Purchasing Power Parity (PPP)[1]. In its classical form, this theory was presented as a simple yet stringent formulation. In this tradition, sustained by characters so dissimilar such us David Ricardo, John Stuart Mill or Alfred Marshall, the basic idea was that of the fulfillment of the “law of one price” where arbitraged markets we warrant the trend toward “one only price” for the same good in every country. This implied that if we took price indexes constructed along the same baskets of goods the real exchange rate would be equal to unity.
This strong “absolute” perspective of the PPP is usually turned down by the fact that the “law of one price” works only for a small sub-sample of tradable goods.
To take its place appeared a weaker “relative” PPP perspective, first developed by Gustav Cassel (1916), who explained that the nominal exchange rate should move mainly according to the difference in the evolution of the relative prices in both countries in question:

1) $s_t = \theta + \left(p_t - p_t^*\right) + u_t$

Where s_t, θ, p_t and p_t^* are the log of the nominal exchange rate, transport costs and rigidities associated with international trade, the log of domestic prices and the log of international prices, respectively. u_t is the random deviations of the exchange rate with respect to its level of parity with average equal to zero and finite variance σ^2. This means that the real exchange rate e_t will be equal to:

2) $e_t = s_t + \left(p_t^* - p_t\right) = \theta + u_t$

From equation 10 it is evident that the RER is the result of a simple long run linear relationship between the nominal exchange rate and the level of the relative prices between tradable and non-tradable goods (approximated by p_t y p_t^*, respectively).

From this relationship we conclude that the equilibrium real exchange rate (ERER) according to PPP could be presented as white noise around a constant (θ).

In different representations there have been attempts to integrate this doctrine of equilibrium RER with the monetary theory, relating it with the Monetary Framework of the Balance of Payment. This new formulation pretends to incorporate additional determinants of the real exchange rate, such as monetary emission or economic growth. However, in the literature it has been difficult to favorably contrast empirically these monetary models of the exchange rate[2].

Previous works have said that even though the real equilibrium exchange rate may not follow a random walk, the most part of its movements should follow changes in real factors (changes in the productivity of production factors, changes in consumer preferences, etc.)[3]. Several papers[4], on the other hand, show that most part of the variance of the real exchange rate is mainly due to shocks of real type.

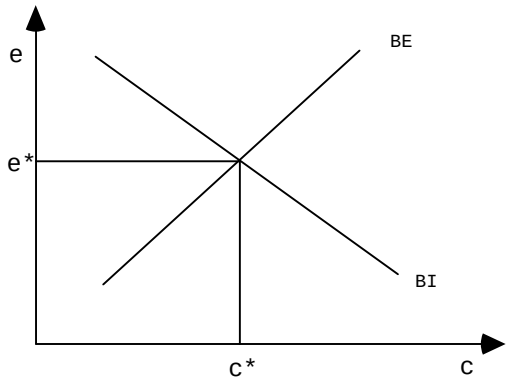
These facts impose the need to look for a more complex concept of equilibrium of the real exchange rate. Thus, in a general perspective the ERER is defined as the one that allows to close the internal and external balance of the economy for certain given "sustainable" values for a number of exogenous "fundamental" variables and certain parameters of long run economic policy.

2.2 A model based on the fundamentals

The internal equilibrium results[5] when the non-tradable goods market "clears". Beginning with a position of internal balance, an increase in expenditure (c) results in excess demand in the non-tradable goods market at the ongoing real exchange rate (e).

To return to a position of internal equilibrium the real exchange rate has to appreciate thus displacing part of the supply towards the production of domestic (non-tradable) goods while simultaneously switching demand towards tradable goods. This equilibrium is represented by the downward sloping BI curve in figure 1.

Figure 1



On the other hand, external equilibrium is that situation in which net asset position of the economy has reached its steady state equilibrium. An increase in expenditure at the ongoing RER results in a bigger deficit (or reduced surplus) in the current account.
To return to the sustainable equilibrium in the external sector, the RER has to depreciate to switch demand towards non-tradable goods and supply to the production of tradable goods (the BE upward sloping curve) and thus eliminate excessive borrowing.
The equilibrium real exchange rate would result of the intersection of both BI and BE curves. Thus, the ERER would be:

3) $$e^* = e^*(C_N, C_T, r^* f^*, ...)$$

Where C_N is consumption of non-tradable goods, C_T is consumption of tradable goods, and $r^* f^*$ is the amount of interest services in the current account, amongst other determinant variables.

2.3 Differences amongst the two approaches

In the Purchasing Power Parity (PPP) theory the main issue as regards the determination of the equilibrium real exchange rate is the election of only one equilibrium level for the whole period in question, without taking into account changes in fundamental variables of the economy.
Thus, the main criticism to this framework is the obvious fact that the real exchange rate should move in time together with its determinants, in such a way so as to assure certain conditions of macroeconomic equilibrium (internal and external). We could hardly think that in the face of changes in the structural variables of the economy (such as the terms of trade, labor productivity, the level of public expenditure, etc) the level of the real exchange rate that allows the external and internal equilibrium to be fulfilled would not change.
Another difference amongst the two frameworks, even more important yet, has to do with the use of information coming from the data versus the use of a priori information. The PPP theory, contrary to the fundamentals approach, relies substantially on an eminently theoretical, a priori, approximation to the determination of the equilibrium real exchange rate.
The fundamentals approach, on the other hand, concentrates on the use of the information contained in the actual data sample for the determination of the equilibrium values of the real exchange rate.

3 Empirical evaluation of the Fundamentals Approach.

Given the extreme volatility and strong downward long run trend it would seem a reasonable assumption that for Argentina the PPP hypothesis is not relevant. For that reason in what follows we'll develop an estimation scheme for the equilibrium RER based on the conceptual framework of the model of fundamental determinants presented above.

3.1 The fundamentals.

The RER could be understood as the result of the interaction of a wide number of short and long run determinants (fundamentals), interaction that is complex and determined by the need to satisfy the structural equilibrium conditions of the economy. The temporal evolution of the position of the internal and external equilibrium (and so the equilibrium real exchange rate) depends on those fundamental or structural factors.

The evolution of the international interest rate or the terms of trade are, for example, two fundamental factors behind the position of the external equilibrium. Thus, a hike in the first one or a deterioration of the second ones, result in the curve BE moving upwards and to the left. For a given level of aggregate expenditure a higher real exchange rate will be required to allow for the payment of interests on the external debt or to induce a bigger trade surplus due to the reduction in the price of our exports.

As regards the internal equilibrium, the composition of aggregate demand is a central element. Greater preference for the consumption of domestic goods (due to a change in the preferences of economic agents) will produce a displacement of the BI curve to the right (as the increase of the equilibrium RER). The increased consumption of non-tradable goods could result from a number of causes, including the change in the distribution of income (towards sectors of the population with greater propensity to consume domestically, probably the owners of the labor factor) or an increase in public expenditure.

Other important factors are those related to the evolution of technical change: investment rate and productivity. An increase in total factor productivity with respect to the World's will result in the progressive reduction on the equilibrium real exchange rate. This could be due to the direct effect of investment in tradable goods sectors, or the indirect effect due to the secular reduction in the price of tradable goods consequence of the proportionally greater increase in this sector's productivity with respect to that in non tradable goods production.

In the present work we have selected six variables as the most important fundamentals[6]. The selection was based in the teachings of other authors, the restrictions as regards reliable data and our own intuition. These variables are:

1. Terms of Trade (TERM), measured by the relationship between the price of exports and the price of imports.
2. Capital Movements (as a % of the GDP).
3. Consumption as a proportion of the Gross Domestic Product (GDP), that is, the average propensity to consume.
4. Relative Productivity (approximated by the ration of Argentina's average product per worker and that of the United States).
5. Real M1, M1 deflated by the Consumer Price Index (CPI).
6. Nominal Exchange Rate (NER).

Before we begin the estimation procedure we believe it's important to analyze the behavior of the different fundamental variables. This analysis will be an important source of a priori information for the construction the econometric model.

3.2 Trend of the Explicative Variables.

The terms of trade and the real quantity of money (real M1) show a similar behavior, although it is obviously independent. The behavior of real M1 is essentially the reflex of the deep process of demonetization of the Argentinean economy resulting from years of high and hyperinflation. The evolution of the terms of trade is the result of the general trend of the price of our exports (in its great majority primary products and commodities).

As regards the ratio of Consumption to GDP it is evident the consumption boom in the beginning of the nineties (result of the successful nominal stabilization). This effect seems to be withering away.

However, the increase in the ratio Consumption/GDP seems to have started to grow even before the upcoming of the hyper inflationary process.
The nominal exchange rate has a strong positive trend until the beginning of the Convertibility Plan. From then on the fixation of the exchange rate, that it's still in place, leveled this trend completely.
The capital movements during the eighties were extremely low while the show an important increase since the currency board was put in place. There is a change in the average level of capital flows, which in since 1991 has fourfold that of the previous period.
Lastly, the evolution of relative average productivity shows great differences between the periods. During the eighties Argentina's productivity showed a deep deterioration with respect to the United States'. At the eve of the nineties there was a structural change that resulted in a break in that trend. Thus average productivity grew about 16% during the nineties, after having fallen an astonishing 80% in the previous decade.

4 Econometric Estimation of the Fundamentals Approach.

The objective of this section is the analysis of the main relationships between the bilateral RER and its fundamentals. We'll also look forward to establishing an appropriate methodological framework to estimate the structural sustainable values for the bilateral RER in the medium run and from them establish the degree of appreciation (or depreciation) of the RER.
To identify the econometric structure that most faithfully reflects the data generating process for each and every one of the variables used in the estimation, we'll be step by step determining the most simple and robust model (in terms of its explicative power) that adapts to the available information. We'll present the following sub-sections: a) Selection of the Structure of Estimation. Endogeneity versus Exogeneity of the fundamentals of the bilateral RER; b) Estimation of with endogenous fundamentals. Autorregresive Vectors and their possible specifications; c) Determination of the variables to include in the Marginal Block; d) Cointegration Analysis in the Marginal Block; e) Estimation of the Equilibrium Real Exchange Rate based on the fundamentals. A methodology with autoregresive vectors that which includes error correction mechanisms (VECM); f) Analysis of the deviations between the equilibrium RER constructed from the fundamentals and the actual RER.

4.1 Selection of the Structure of Estimation. Endogeneity versus Exogeneity in the fundamentals of the RER.

For the determination of the equilibrium RER as well as for estimating the relationships between the RER and the different "fundamentals", the traditional methodology consisted in assuming that these last variables were exogenous for the RER. This meant that the real exchange rate did not affected its fundamentals. This methodology was adopted by Baffes, Elbadawi and O´Connell (1997), Razin and Collins (1997) and Edwards (1989).
Although it is possible, and even theoretically preferable due to its instrumental simplicity, that the determinants of the RER be exogenous this condition should be verified. If it were not true the estimated coefficients by Ordinary Least Squares (commonly used for econometric estimation of the RER) result inconsistent, deriving in erroneous interpretations of the existing interrelationships between the variables of the model[7].
There has been a wide discussion as regards the concept of exogeneity with respect to the difference between the notions of weak, strong and super-exogeneity[8], as well as the different tests for their verification.
To be able to correctly identify the structure of estimation (with consistent parameters apt for accurate prediction) it is necessary to test the existence of "strong exogeneity". This implies "weak exogeneity"[9] plus the lack of feedback between the independent variables (in our case the fundamentals) and the dependent one (the RER).

Amongst the most commonly used test for the verification of these sort of restrictions we find the Hausman exogeneity test (1978) (in some occasions identified as the Durbin (1954)-Wu (1973)-Hausman (1978) test) and the Granger Causality test (1969).
For the verification of strong exogeneity in the fundamentals of the RER we'll use this last methodology based on a bi-variate structure for the RER and its fundamentals taken one by one.
The procedure consists on estimating the parameters of the following system of equations:

$$\Delta TCR_t = \sum_{j=1}^{k} (\theta_j \Delta TCR_{t-j} + \beta_j \Delta x_{t-j}) + \varepsilon_t$$

4)

$$\Delta x_t = \sum_{j=1}^{k} (\lambda_j \Delta x_{t-j} + \alpha_j \Delta TCR_{t-j}) + \nu_t$$

Where:
xt is the fundamental on which we wish to the hypothesis of exogeneity,
εt and νt are the residuals of the estimated equations,
j is the number of lags,
θ, β, λ and α are the estimated parameters and
Δ is the difference operator

Testing, through an F statistic, the following hypothesis on the first equation:
$H_{0x} : \beta_j = 0$ for every j.
And the following hypothesis on the second equation:
$H_{0TCR} : \alpha_j = 0$ for every j.
Next, we present the results for the tests of the different hypothesis H0TCR . We do not include the test for the H0x, hypothesis since we are just trying to verify the exogeneity of the variables included in x (the fundamentals). The verification of the effect of the fundamentals on the RER will be tested later with a multivariate VAR during the selection of the marginal block.

Table 1 Granger Causality Test

	Probability				
Hypothesis	**4 Lags**	**5 Lags**	**6 Lags**	**7 Lags**	**Average**
TRCB does not Granger Cause TERM	68,5%	82,9%	69,9%	67,1%	72,1%
TRCB does not Granger Cause MCAP	32,7%	45,6%	20,4%	28,6%	31,8%
TRCB does not Granger Cause PROD	23,8%	28,2%	28,1%	45,8%	31,5%
TRCB does not Granger Cause CONS	26,7%	14,2%	31,1%	41,8%	28,5%
TRCB does not Granger Cause M1R	3,6%	1,2%	0,4%	1,0%	1,5%
TRCB does not Granger Cause TCN	5,4%	1,3%	1,9%	3,7%	3,1%

We find that at a 95% confidence level we cannot accept in any case the lack of feedback of the TCR on its fundamentals. That is we cannot accept significantly that the RER does not Granger cause (anticipate) the rest of the variables. With the exception of the Terms of Trade[10] the rest of the "fundamentals" clearly cannot be treated as strongly exogenous. For this reason for the estimation of the real exchange rate we need to use an econometric structure that takes into account the endogeneity of the different variables thus eliminating the problem of inconsistency in the coefficients estimated by OLS in a uni-equational model.
4.2 Estimation with endogenous fundamentals. The Autorregresive Vectors and its possible specifications.

The models developed from autorregresive vectors follow the requisites established above and its standard form for a model with 2 equations is given by:

5)
$$y_t = a_{10} + a_{11}.y_{t-1} + a_{12}.z_{t-1} + e_{1.t}$$
$$z_t = a_{20} + a_{21}.y_{t-1} + a_{22}.z_{t-1} + e_{2.t}$$

Where the innovation errors of these equations are a linear combination of the errors of the primitive reduced form, as it is presented in Enders (1995) and Carrera, Féliz and Panigo (1997).

Within the vector autorregresive models there exist different alternatives of specification depending on the type of restrictions of identification that we whish to incorporate in the model to estimate be they the result of economic theory or proceeding from the data generating process[11]. Some of these specifications are those developed by Sims (1980) for unrestricted VARs (where cointegrated variables do not exist and no ad-hoc long run relationships are forced). Blanchard and Quah (1989) for structural VARs (where from economic theory based assumptions long run relationships amongst the variables are imposed) and Johansen (1988) for VAR with cointegrated variables (or Vector Error Correction Models which incorporate long run relationships obtained from the data generating process).

Our work tries to reduce the level of discretionary selection to a minimum. For that reason we'll analyze the characteristics of integration for each variable as a first step to be able to derive the restrictions needed to determine the optimal specification of the VAR required by the data generating process.

At a confidence level of 99% for no variable can we reject the hypothesis that they are integrated of order one[12].

If we relax the requisites and only whish to obtain a 5% significance level (95% confidence) we notice that the bilateral real exchange rate is stationary (around a stochastic linear trend[13]) as are relative productivity and the capital flows with respect to GDP. The ratio Consumption/GDP, the Terms of Trade, the nominal exchange rate and real M1 are still integrated of order one.

Having verified the non stationarity of at least some of the variables included in the estimation there is the possibility that there exists cointegration between them. This situation has to be contemplated for the incorporation of the long run relationships (if they existed) in the autorregresive model to be estimated.

4.3 Determination of the variables to be included in the Marginal Block.

Prior to the cointegration test we must determine the variables to include in the analysis. Amongst the variables chosen as "fundamentals" of the RER (Terms of Trade, real M1, Consumption/GDP ratio, Capital Flows/GDP ratio, relative productivity and nominal exchange rate) some could prove to be not significant for the data generating process for the RER (although there may be strong theoretical reasons for their inclusion). If this where the case they should be excluded from the marginal block of estimation[14].

To reach this objective, we developed a recursive exclusion test based on the structure of the Likelihood Ratio Test (LRT)[15]. We begun with the estimation of an unrestricted VAR in levels that included the bilateral real exchange rate (TCRB), the Terms of Trade (TERM), relative productivity (PROD), real M1 (M1R), Consumption/GDP ratio (CONS), the Capital Flows/GDP ratio (MCAP) and the nominal exchange rate (TCN). We followed with the estimation of increasingly restricted VARs (also in levels) excluding first one variable at a time, then two variables at a time, and so on. This was done until we exhausted all possible combinations (combinations of 7 variables taken 6 at a time, combinations of 7 variables taken 5 at a time, etc). For all estimations we took the log of the determinant of the error variance-covariance matrix to calculate the observed Chi squared value later used in the LRT for the exclusion of variables.

If the observed value was less than the critical value calculated for the degrees of freedom imposed by the reduction in the parametric space at a significance level of 10%, then we accepted the fact that the excluded variables did not increase in a significant manner the explicative power of the model and thus could be ruled out in the marginal block of estimation[16].

In the following tables we present the main results:

Table 2. Exclusion Test for the Selection of the Marginal Block

Variables		Observed Value	Critical Value at 10% significance
Included	**Excluded**		
TCRB,TCN,M1R,CONS,PROD,MCAP,TERM			
TCRB,TCN,M1R,CONS,PROD,MCAP	TERM	94,7	95,48
TCRB,TCN,M1R,CONS,PROD,TERM	MCAP	70,9	95,48
TCRB,TCN,M1R,CONS,MCAP,TERM	PROD	111,7	95,48
TCRB,TCN,M1R,PROD,MCAP,TERM	CONS	131,1	95,48
TCRB,TCN,CONS,PROD,MCAP,TERM	M1R	79,3	95,48
TCRB,M1R,CONS,PROD,MCAP,TERM	TCN	81,3	95,48
TCRB,CONS,PROD,MCAP,TERM	TCN,M1R	89,24	82,10
TCRB,M1R,CONS,PROD,TERM	**TCN,MCAP**	**80,42**	**82,10**
TCRB,M1R,CONS,PROD,MCAP	TCN,TERM	103,03	82,10
TCRB,TCN,CONS,PROD,TERM	M1R,MCAP	82,93	82,10
TCRB,TCN,CONS,PROD,MCAP	M1R,TERM	109,87	82,10
TCRB,TCN,M1R,CONS,PROD	MCAP,TERM	112,52	82,10
TCRB,CONS,PROD,TERM	TCN,M1R,MCAP	97,1	68,78

The most parsimonious marginal block we could find does not include the nominal exchange rate (TCN) or the capital movements (MCAP) without losing in a significant manner explicative power.

As we have indicated, the next step consists in performing the Cointegration Test between the variables of the Marginal Block. This will allow us to determine the long run relationships (between these variables) to be included in the structure of estimation.

4.4 Cointegration Analysis in the Marginal Block.

> *"While nonstacionarity of the data was previously considered a nuisance and therefore largely ignored, recent experience with cointegration analysis has pointed to its great potential as a statistical means to distinguish between long run relations and short run dynamics adjustment".* Johansen y Juselius (1992).

The previous sentence, by those considered to be the main referents of the cointegration methodology, is clear as regards identifying the advantages of using a process of estimation that allows to "statistically" determine the long run relationships as well as the short run adjustment mechanism.

Mougillianski (1995), Mujica (1997), and Arena and Tuesta (1998) have produced some recent empirical developments of this methodology[17] applied to the RER.

To use this type of structure of estimation we must first verify the number of long run relationships that exist between the variables in the marginal block. This can be done using Johansen's methodology that consists in identifying the number of linearly independent cointegration vectors in a general model with n autorregresive vectors.

In our case, this general model will have 5 variables in its marginal block of estimation (RER, Terms of Trade, real M1, Consumption/GDP ratio and relative productivity). The number of linearly independent vectors has been estimated using Johansen's test for 7, 6 and 5 lags trying to verify the sensibility of the results to changes in the structure of lags.

This procedure was performed in two different specifications using the Eviews 2.0 software package[18]. In the first place the test was done with the inclusion of a constant and a linear trend in the error term.

Secondly, we performed the test with the exclusion of the trend. The results from theses tests[19] are robust since they remain invariant to the changes in the lag structure. Taking into account that in every case the linear trend included in the error term was significant Johansen's test indicates the existence of 3 linearly independent cointegration vectors that should be incorporated in the structure of the VAR to correctly identify the long run relationships amongst the variables.

We proceed to identify the final structure of estimation of the model of autorregresive vectors, which will take the form of a VECM:

6) $$\Delta X_t = C + \sum_{i=2}^{k} \theta_{t-i} . \Delta X_{t-i} + \alpha . \beta' . X_{t-1} + \gamma . D$$

Where: X y C are 5 x 1 matrices that include the variables of the marginal block and the constants for each equation, respectively; D is a 3 x 5 matrix that includes, for each equation, the dummies that identify the hyperinflation, the Convertibility Plan and the Tequila; θ is a 5 x 5 matrix that contains the parameters that determine the short run relationships; β is a 3 x 5 matrix that includes the parameters of all 3 linearly independent vectors of cointegration of the variables included in the marginal block; α (Also a 3 x 5 matrix) containing the parameters that specify the velocity of adjustment from dis-equilibrium positions and γ is the matrix that details the response of each equation to the dummy variables included in D.

Using quarterly data for the variables in logs and seasonally adjusted with the X11 ARIMA methodology, we performed the estimation procedure for the system of vectors of cointegration for the period 1980:1-1997:4.

First we have to verify the optimal structure of lags consistent with the most parsimonious model that we are able to specify without altering in a significant manner the predictive properties of the VECM. For this procedure we had to confront the results of three different tests that are commonly used for to this end: the Schwarz criterion, the Akaike criterion and the Likelihood Ratio Test (LRT). Due to the simplicity of its implementation we started verifying the results of the first two tests, but they showed contradictory results since the first determined that the VECM should include just 1 lag while Akaike's criterion recommended 6 lags.

To solve this contradiction, we calculated, in recursive manner, the LRT between an unrestricted 7 lag model and other restricted models to which we were progressively subtracting lags (one at a time)[20]. The LRT indicates (coinciding with Akaike's criteria) the optimal number of lags to be 6. The difference between this result and that of Schwarz's criteria is closely related to the excessive penalization this last test gives to the reduction in the degrees of freedom[21].

Having determined the optimal structure of lags and knowing that, for that structure, there exist 3 linearly independent cointegration vectors, we can move on to obtaining the parameters we'll use for the calculation of the equilibrium RER. Since this parameters will be estimated in a system of equations that allows for the endogeneity of the fundamentals of the RER they avoid the problem of inconsistency found in the uni-equational estimation of those parameters[22].

5 Estimation of the Equilibrium Real Exchange Rate (ERER) based on the fundamentals. A methodology with autoregressive vectors that include an error correction mechanism (VECM).

Once we've estimated consistent parameters[23] we can, following some of the procedures of Edwards (1989) methodology, find a series for the equilibrium real exchange rate in the medium run. More precisely, having found the short and long run relationships between the RER and its fundamentals for the calculation of the ERER we change the actual series replacing them by the "sustainable medium run" values.

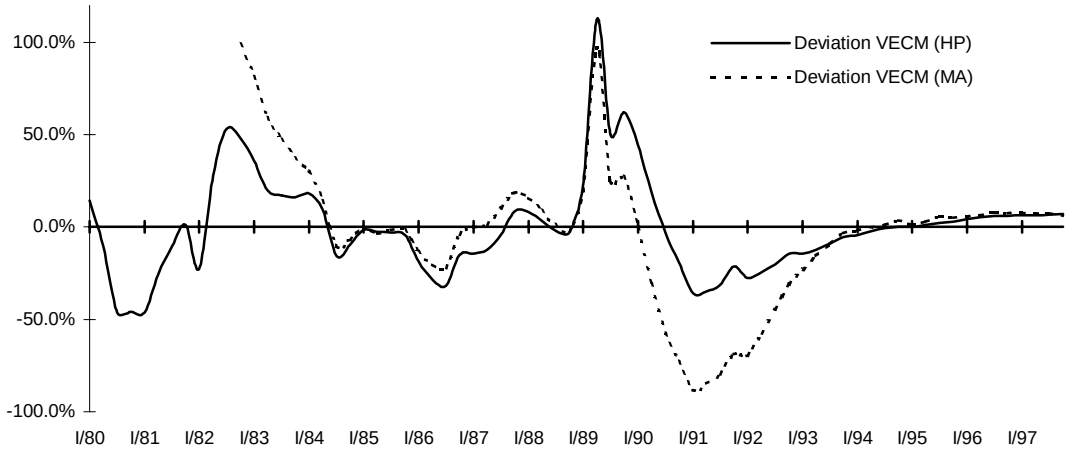
This values, unlike the ad-hoc equilibrium values that Edwads (1989) proposes, avoid discretional decisions as regards the "equilibrium value" in the medium run for each of the variables included in the system.

The selection of the sustainable values for the medium run has generated controversy in the literature. Baffes, Elbadawi and O´Connell (1997) use stochastic trends deduced from Beveridge and Nelson's (1981) procedure or 5 year moving averages and deterministic linear trends, verifying minor differences amongst their results.

In a more recent work, Jiménez (1997) and Arena and Tuesta (1998) use the smoothed stochastic trends obtained from the Hodrick-Prescott filter (1980) to estimate the equilibrium values for the variable to be estimated (in our case the bilateral RER).
In the light of these alternatives to check the robustness of the results in the estimation of the equilibrium bilateral real exchange rate in the medium run, we'll estimate it from the Hodrick-Prescott values and also from the 3 year moving average for each of the variables included in the system.
Subtracting to the actual series the estimated equilibrium values we can calculate the degree of over (under)-valuation of the real exchange rate in each moment of time.

Figure 3

Deviations of the bilateral RER with respect to its equilibrium value calculated based on its fundamentals.



5.1 Analysis of the deviations between the equilibrium RER calculated from its fundamentals and the observed RER.

The analysis of the deviations of the observed bilateral RER with respect to the sustainable equilibrium RER show some important common characteristics in both the moving average and HP trend methodologies.
Both present a strong increase in the positive and negative deviations associated with the hyperinflation and latter successful stabilization, respectively. That is, the acceleration in the inflationary process is associated with the depreciation of the RER and the its abrupt reduction associates with an initial appreciation.
We also see that, as a general rule, the deviations of the RER with respect to its equilibrium are less marked when using the HP trends for the fundamentals[24]. The motive for this is that the HP filter tends to penalize strongly cycles of short duration. See, for example, the case of the first quarter of 1991.
We can establish six periods that are clearly identifiable.
The first period, 1982-1984, relates to the debacle of the military government and the period of Grispun's ministry in the beginning of President Alfonsin's government. The main characteristic of this period is the depreciation of the observed RER with its maximum (53%) occurring during the Malvinas War.
The following period goes from the second quarter of 1984 to the first one of 1987. The most relevant economic fact of the period is the implementation of the Plan Austral. This plan produced a transitory stabilization of the nominal variables and is a period of a certain stability of the RER around its equilibrium. By the end of 1986 during the existence of a fixed exchange regime the

RER appreciated 30% (an important amount for a period of external credit rationing) which was latter corrected by a devaluation.
The following period, from the fourth quarter of 1987 to the end of 1988, is another one of abrupt depreciation that eventually tended towards equilibrium. This period is associated we the successor of the Austral Plan, the Plan Primavera.
The next period was that of 1989-1990, were the RER depreciated abruptly 112% with respect to the equilibrium level. 90% of this depreciation occurred in just one quarter. The RER went back to its equilibrium faster for the moving average measure than than for the HP trend measure (second quarter of 1990 against the fourth quarter of 1990).
Between 1990 and 1994 we observe a long period of appreciation of the RER (17 consecutive quarters), with the greatest appreciation in the quarter previous to the beginning of the Convertibility (36% with respect to the HP trend and 88% with respect to the moving average equilibrium). The cycle of this appreciation is very asymmetric since it's minimum value was reached in only 3 quarters. After that it starts a process of correction that takes the RER to its equilibrium in the third quarter of 1994. This convergence results from the appreciation of the equilibrium RER in its two alternative presentations.
The last relevant period for this sample is the one beginning with the Tequila. This one shows the RER with certain stability around 6% of depreciation. The moving average indicator shows its maximum depreciation in the third quarter of 1996, then beginning a process of slow appreciation.

6 The problem of the parameter stability. A Rolling VECM alternative.

What is often criticized as regards the estimation of the parameters with time series is that they might not be constant across different parts of the sample. For example, in presence of structural breaks the relationships amongst the variables in a model may suffer significant changes along in time.
If that were true for our case, the ERER estimated by a single VECM for the whole sample could be significantly different from the actual equilibrium real exchange rate.
Taking into account the possibility of such a problem (and knowing that in our sample period there have been events that could have led to structural changes), we analyze the stability of the model estimated in the previous section.
One of most frequently used tests to check for parameter stability is Chow's Breakpoint Test[25]. The idea of this test is to check whether the residuals for an equation estimated for one sample period are significantly different from the sum of the residuals for the same equation estimated separately for two sub-samples. The break is established where the researcher believes the structural change (that should cause parameter instability) might occur.
However, for our purpose this test is of no use since it was designed for uni-equational econometrics, not for the Vector Error Correction Models we estimate in this paper.
Hypothetically we could check the stability of the parameters of each equation in the VEC model separately. The problem is that a criterion for saying whether the parameters in the model as a whole are stable if, for example, for half the equations we find parameter stability while for the other half we don't, has not been developed yet.
Similar problems are found for other parameter stability tests such as the Recursive Coefficients Test, the One-Step Forecast Test, the Recursive Residuals Test[26], CUSUM and CUSUMSQ Tests[27] (to name a few) all of which have been designed for uni-equational econometrics and thus are not suitable for multi-equational systems.
A different test was proposed to evaluate hypothesis in a system of equations: the Likelihood Ratio Test (LRT)[28]. However as Enders (1995) states, "the LRT is only applicable when one model is a restricted version of the other". In addition, this test should be carried out holding the same sample

for both the restricted and the unrestricted version of the model. The quoted conditions can not be satisfied when the stability of parameters is evaluated for a system of equations as a whole[29].
For these reasons, we develop an alternative procedure both to verify "the stability of the model" and to estimate an equilibrium exchange rate that takes into account the possible changes in the estimated parameters.

6.1 A Rolling VECM

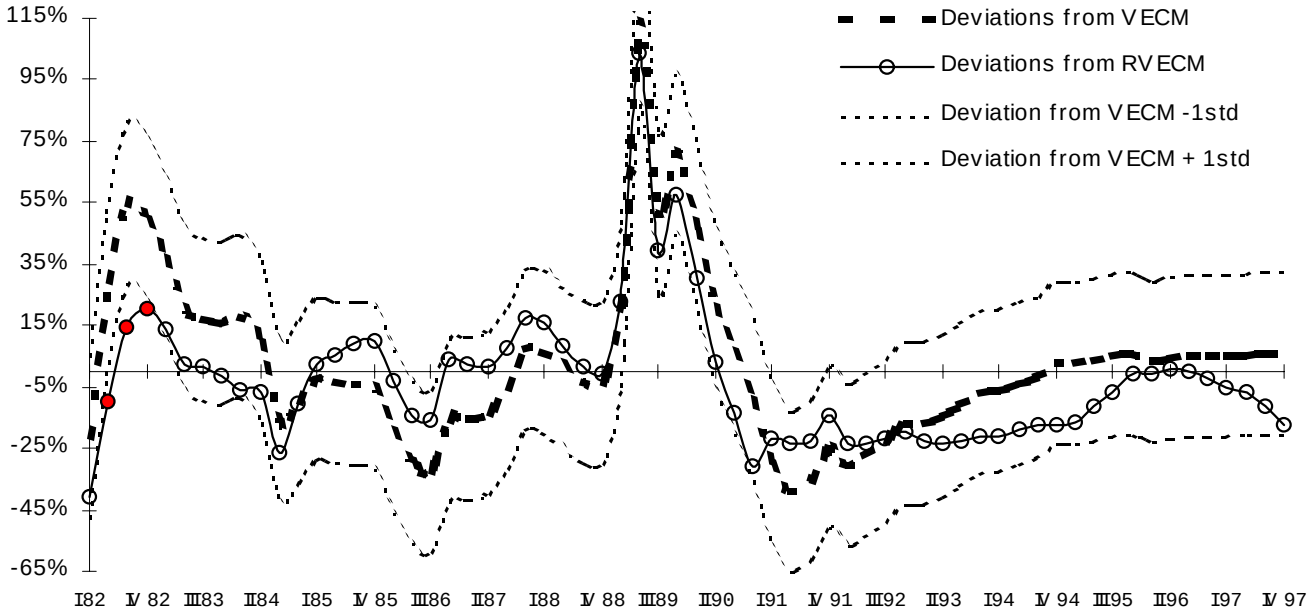
Using the same restrictions of the original VECM (included variables, lag length and number of cointegrating vectors), we estimated twenty different rolling models changing the sample period but holding constant the sample size (44 quarters, the minimum size possible due to the degrees of freedom required by the model)[30].
We did not include the dummy variables for the "Hyperinflation", "the Convertibility" and the "Tequila" since it is in our interest that the rolling procedure captures the influence of these events.
After the parameter estimation, we follow the same procedure described in the determination of the ERER with the original VECM. This resulted in 20 series of ERER, one for each rolling VECM.
In order to determine a single relevant ERER we calculated the weighted average of the 20 series. From each series we only took into account the values corresponding to the sample period used for the parameters' estimation in that particular series[31].

6.2 Comparing the VEC and the rolling VEC. A test and a complement to the traditional VEC approach

In order to test the parameters stability in the general VECM model previously calculated, we compare the deviations of RER respect to the ERER obtained from the two approaches of VEC: the general VECM for the whole sample and the Rolling VECM. In figure 4 we show both deviations. In the case of Rolling VECM we present the confidence interval of one plus/minus standard deviations so we can see that the Rolling VECM series is most of the time inside (except for three observations) the limits of confidence.

Figure 4

Deviations of the RER from the ERER calculated with the General VECM and the Rolling VECM



Looking at the deviations from ERER that were calculated with each model we find that they are in general very similar.

First of all, we see that in most of the sample the series move together, so the contemporaneous correlation is very high, except in 1997.
As a general rule it is observed that the rolling VEC tends to smooth the deviations of observed RER from the equilibrium RER, so the absolute value of deviations is lower in for rolling VEC model. This behavior is regular along the sample except for the sub-periods III92-III95 and for the year 1997, the last one in the sample.
The lesser deviation in absolute value observed is consistent with the fact that the Equilibrium Real Exchange Rate calculated from the rolling VEC is more volatile than the other because of the possibility of change in the parameters, so in this way the observed RER are always closer to it.
Therefore, this evidence allows us to affirm, as a general result, that there is not strong evidence of great parameters instability. Or at least the structural change does not appear so important as to invalidate the estimation of the general VEC.
To confirm this we can calculate the rolling correlation coefficient[32] between both series. It is near 0,845 for the whole sample.
It is important to examine the divergent behavior observed after the convertibility plan because it prevents us about a potential structural change. As we can see in the year 1997 the general VEC deviations is showing an average depreciation of 5% in contrast with an appreciation of 9% as regards the ERER from the rolling VEC. In the last observation of IV1997 we observe that the deviations of Rolling VECM is moving towards the limits of the confidence interval.
However, this divergence seems natural given the different elaboration of the indicators. In the case of rolling VEC the parameters are giving more attention to convertibility period and specially the Asian crisis of 1997 than in the case of the general sample. When the scope of the researcher is mainly forecasting it could prove important to pay attention to the alternative methodology that we propose here.
So, in addition to use the Rolling VEC methodology as a test of parameter stability we can use it as a complementary tool for evaluating real exchange misalignments (as well any type of general VEC).

7. Synthesis, conclusions and future extensions.

A relevant aspect to the analysis of the RER lies in its characterization as a stationary series around a trend. This would indicate that shocks have a permanent effect on the variable. In terms of economic policy this means that the variable does not return to its old equilibrium after a shock, making adequate the use of policy measures that would accelerate the adjustment of the economy. If the variable were I(0) around a constant we could think that it returns to its mean automatically: In other terms, the economy has a correcting mechanisms (unless we could prove that this behavior is the result of the economic policy itself).

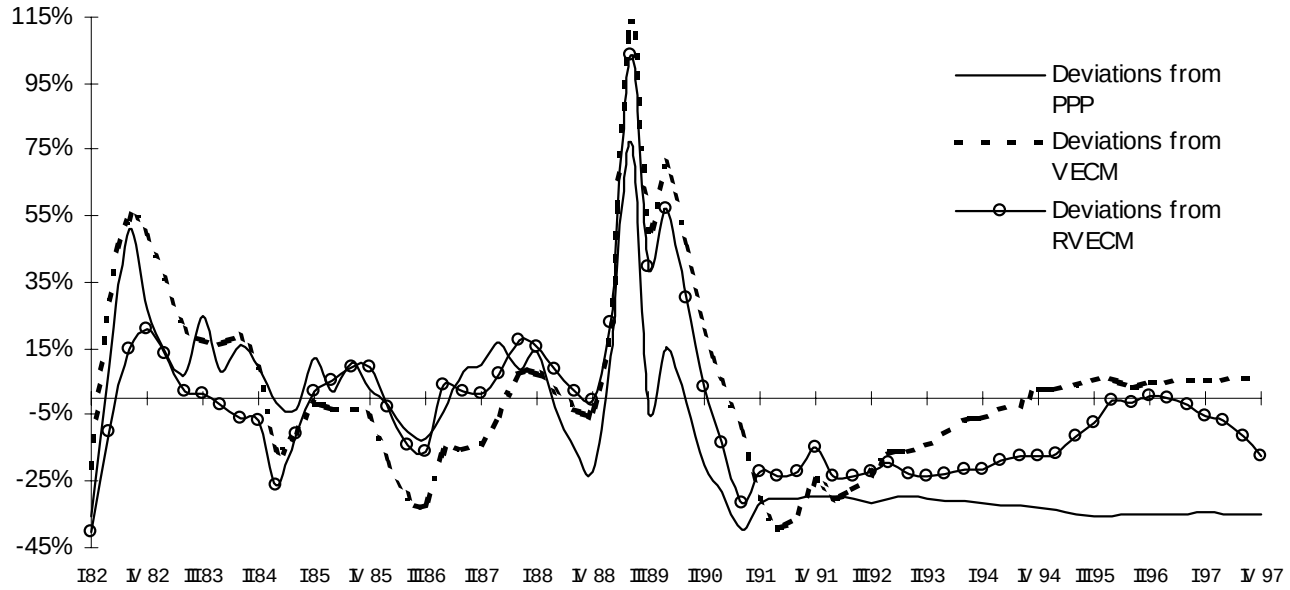
It is evident that the equilibrium RER in the medium run is affected by the sequence of shocks as they occur. Though theoretically it should be tied only to permanent shocks, identifying the type of shock is difficult when they occur and this is a problem for the policy designer that wishes to know *ex-ante* if the equilibrium has changed. For example, a negative external shock such as the one started in 1997 generates a change in relative prices: ¿is it permanent or transitory?, ¿should the economic structure adapt or not to the new vector of relative prices or is it better to compensate it through economic policy under the assumption that it is just transitory?

From the equilibrium RER constructed through the VECM, in its HP version as well as with moving averages, we see that we can clearly define two levels for the equilibrium RER: one for the period 82-90 and another significantly lower for the period 91-97. The existence of different levels for the equilibrium RER is a contradiction with the predictions of the PPP model that states that the RER oscillates around a unique equilibrium value. Their difference and why it remains seems to depend, for the case of Argentina, on the access to the international financial markets.

When we compare the deviations of the bilateral RER with respect to the PPP criterion[3334] with the results obtained from the deviations of the equilibrium value based on the fundamentals[35] we find important differences.

Figure 5

Comparative analysis of the deviations calculated with the PPP and the Fundamentals approach



The deviations with respect to the PPP show bigger extreme values, in appreciation as well as in the depreciation. For the whole sample, we find two clearly defined periods, the turning point being the Convertibility Plan.

In the first stage, we see that both deviations have a positive and highly correlated behavior (the correlation coefficient between the two series is 0.81 in 1980:I-1991:I).

Since 1991 the theories give opposite results (the correlation coefficient being equal to –0.77 in the period 1991:II-1997:IV). While according to the PPP methodology the bilateral RER (deflated by the CPI) has been in the period about 35% under its equilibrium value, according to its equilibrium based on the methodology of the Fundamentals, the appreciation has slowly been correcting between 1991 and 1994.

However, the two alternative way of computing a VECM give a different result in the level of appreciation (bigger in the rolling VECM) and in it trend for the last period. While the general VECM shows that the RER is depreciated and stable around a 5% depreciation; the rolling VECM shows a tendency to appreciation (on average a 9% in 1997) that is correlated with the deterioration of Terms of Trade after the Asian crises.

As a general remark what we can appreciate that in high inflation periods, were the nominal variables have great influence on the behavior of the RER, the PPP framework does not seem to diverge greatly from the Fundamentals approach. However, when the volatility of the nominal variables ceased to have an important role[36] , the real variables come into play as the determinants of the equilibrium. This comes from the fact that the growing discrepancy, in the nineties, between the PPP and the fundamentals' approach has to do with the appreciation of the equilibrium RER a fact only taken into account by these latter methodology.

The appreciation is associated with 1) the strong increase in Argentina's productivity with respect to the United States', 2) the increase in the demand for real money balances that, in a fixed exchange rate regime, was associated with the fact the that capital flows did not have inflationary effects, and

3) the continuous improvement in the terms of trade from the year 1991 to the Asian crisis, reduced the level for the RER that was necessary to maintain the equilibrium[37]. The following figure shows the changing behavior in these three fundamentals in the period under analysis (80-97).

Thus, we can conclude that to analyze the equilibrium in the RER a framework based on the fundamentals results superior to one based on the PPP theory, especially when we study nominally stable economies.

In our opinion it is always recommended to use the methodology for controlling parameter stability and structural change. We propose the rolling VECM method as a tooll for this task. Additionally, it is advisable to use this alternative VECM as a complement in calculating fundamentals equilibrium RER.

While as a methodological contribution this conclusions are strong, it is convenient to further interrogate into the characteristics of the observed equilibrium level. The variables selected are similar to those chosen in most of the literature on the real exchange rate even when in our case we have performed the estimation based on a criterion of endogeneity of the variables that determine and are affected by the RER. As regards the results of the estimation for the most recent period we should question whether the economy is in a state of internal and external equilibrium with a rate of unemployment of 13-15%. Without intending to be conclusive, we can provide some answers. The RER may not have a strong relationship with the job market and thus different levels of equilibrium RER do not affect the demand or supply for labor in the relatively closed Argentinean economy. This relies in the fact that with the RER neighboring its equilibrium level since 1994, unemployment rate went up from 10% to 14% (with peaks of 16%). Another alternative, the most likely in our opinion, is that in the models based on the fundamentals approach the problems of internal equilibrium are not sufficiently developed.

> *"The equilibrium real exchange rate is that relative price of tradable to non-tradable goods that, for sustainable (equilibrium) values of other relevant variables – such as taxes, international prices and technology – produces simultaneously the internal and external equilibrium. The internal equilibrium means that the market for non-tradable goods clears in the period and it is expected to stay cleared in future periods. This definition of the equilibrium real exchange rate implies that the equilibrium occurs at its natural rate". Edwards (1989).*

The problem is assuming as internal equilibrium a situation in which the non-tradable goods market equals supply and demand and that this could actually be compatible with different levels of unemployment if we leave that assumption that markets adjust completely and that imperfections that are an obstacle for that process are present.

What we observe for the case of Argentina is that the determination of the equilibrium RER seems to be independent of the lack of it in the job market, which is not to say that it does not affect it. A hypothesis to be verified would be that the RER could induce dis-equilibriums that the economy takes time in adjusting and this dis-equilibrium does not affect the RER because there are other determinants that counter this effect. For example, an increase in the terms of trade of a change in expectations of international investors as regards the country, may keep the equilibrium RER over that required if only the need to equilibrate the job market was taken into account. In conclusion, a positive external shock hides the internal dis-equilibrium that together with a fixed nominal exchange rate, insufficient flexibility of internal prices and the practical impossibility of reassigning the labor force shut out the possibility of adjustment through feedback to the RER.

This problem requires further analysis as regards the links between the labor market, international integration of the economy and the RER.

8. References

Akaike, H. (1973) “Information Theory and an Extension of the Maximum Likelihood Principle” in B. Petrov and F. Csake (eds), 2nd International Symposium on Information Theory, Budapest, Akademiai Kiado.

Amisano, G and Giannini, C. (1997) ”Topics in Structural VAR Econometrics”. Springer-Verlag Berlin Heilderberg. New York.

Arena, M. and Tuesta, P. (1998) “Fundamentos y Desalineamientos: el tipo de cambio real de equilibrio en el Perú”.

Baffes, J., Elbadawi, I., O'Connell, S. (1997) "Single-equation estimation of the Equilibrium Real Exchange Rate", mimeo.

Baxter, M. (1994) “Real Exchange Rates, Real Interest Differentials, and Government Policy: Theory and Evidence”. Journal of Monetary Economics, 33.

Beveridge, S. and Nelson, C. (1981) “A new approach to decomposition of economic time series into permanent and transitory components with particular attention to measurement of the bussiness cycle”, Journal of Monetary Economics, Nº7, 151-174.

Blanchard, O. and Quah, D. (1989) “The Dynamics Effects of Aggregate Demand and Supply Disturbances”. American Economic Review, 79, 655-673.

Brown, R.L. Durbin, J. and Evans J. (1975) “Tecniches for testing the constancy of regression relationships over time” Journal of the royal Statistical Society Series b 37.

Buscaglia, E. A. (1997) "Argentina: Paridad internacional en U$S. Del producto interno y tasas reales de cambio". Academia Nacional de Ciencias Económicas.

CACES (1998) “Análisis integral de las fluctuaciones macroeconómicas en Argentina y Brasil”. Documentos Técnicos del CACES, CACES-UBA.

Campbell, J. y Clarida, R. (1987) “The dollar and real interest rates”. Carnegie-Rochester Conference Series on Public Policy 27.

Carrera, J., Féliz, M. y Panigo, D. (1998) "Economic Integration and Interdependence". CACES, mimeo.

Carrera, J., Féliz, M. y Panigo, D. (1997) "Shocks económicos en el Mercosur". En los Anales de las Jornadas de la Asociación Argentina de Economía Política.

Cassel, G. (1916) “The Present Situation of the Foreing Exchange”, Economic Journal, 26.

Charemza, W. and Deadman, D. (1992) “New Directions in Econometric Practice”, Aldershot, Hants.: Edward Elgar.

Clarida, R. and Gali, J. (1994) “Sources of Real Exchange Rate Fluctuations: How Important are Nominal Shocks”, WP4658, NBER.

Cushman, D., Sang, L. and Thorsteinn T. (1995) “Maximum likelihood estimates of cointegration in exchange rate models for seven inflationary OECD countries”, Journal of International Money and Finance.

Darnell, A. (1994) “A Dictionary of Econometrics”. Edwars Elgar.

Dickey, D. and Fuller, W. (1979) “Distribution of the Estimates for Autoregressive Time Series with a Unit Root”. Journal of the American Statistical Association, 74, 427-431.

Dickey, D. and Fuller, W. (1981) “Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root”, Econometrica, 491057-1072.

Durbin, J. (1954) “Error in Variables”, Review of the International Statistical Institute, 22, 23-32.

Dornbush, R. (1992) “Purchasing Power Parity”, in Newman, Milgrate and Eatwell, The New Palgrave Dictionary of Money and Finance, The Macmillan Press, New York,236-244.

Edison, H. and Pauls, B. (1993) “A re-assessment of the relationship between real exchange rates and the real interest rates: 1974-1990”. Journal of Monetary Economics.

Edwards, S. (1989) “Real Exchange Rates, Devaluation, and Adjustement” MIT Press.

Enders, W. (1995) “Applied Econometric Time Series”, John Wiley and Sons Pubs.

Engel, C., Hendrickson, M. K., Rogers, J. H. (1997) "Intra-national, intra-continental and Intra-planetary PPP". Board of Governors of the Federal System, International Finance Discussion Papers, No. 589.
Evans, M. and Lothian, J. (1993) “The response of exchange rates to permanent and transitory shocks under floating exchange rates”. Journal of International Money and Finance.
Geweke, J. (1984) “Causality, Exogeneity and Inference” in W. Hildenbrand (ed), Advances in Econometric, Cambridge: Cambridge University Press.
Granger, C. (1983) “Co-integrated variables and error correction models”, UCSD Discussion paper Nº13.
Granger, C. (1969) “Investigating Causal Relations by Econometric Models and Cross-Spectral Methods”, Econometrica, 37, 424-438.
Granger, C. and Engle, R. (1985) “Dynamic Model Specification with equilibrium constrains: Co-integration and error- Correction”, UCSD Discussion paper.
Granger, C. and Weiss, A. (1983) “Time Series Analysis of Error Correction Models”, in Academic Press, Studies in econometrics time series, and multivariate statistics.
Hamilton, J. (1994) “Time Series Analysis”, Princeton University Press.
Harvey, A. (1981) “The Econometric Analysis of the Time Series”, London School of Economics. Handbook in Economics.
Harvey, A. (1990) “The econometric analisys of time series” Philip Alan.
Hausman, J. (1978) “Specification Test in Econometrics”, Econometrica, 46, 1251-1271.
Hendry, D. and Ericsson, N. (1991) ”An econometric analisys of U.K. money demand in Monetary trends in the United States and United Kindong by Friedman, M. and Schwartz, A. AER 81.
Hodrick, R. and Prescott, E. (1980) "Post-war U.S. business cycles: an empirical investigation". CMU University, D.P., No. 441.
Huizinga, J. (1987) “An empirical investigation of the long-run behavior of real exchange rates”. Carnegie-Rochester Series on Public Policy.
Jimenez, F. (1997) “Ciclos y determinantes del crecimiento económico: Perú 1950-1996”, Revista Economia, Nº20, 103-164, Departamento de Economía Pontificia, Universidad Católica del Perú.
Johansen, S. (1995) “Likelihood Based Inference in Cointerated Vector Autorregresive Models”, Oxford University Press, Oxford.
Johansen, S. (1988) “Statistical Analysis of Cointegration Vectors”. Jouranl of Economics Dynamics and Control, 12, 231-254.
Johansen, S. and Juselius, K. (1992) ”Identification of the long-run and short-run Structure. An Application to the IS-LM Model”, Journal of Econometrics, 63, 7-36.
Johnston, J. (1984) “Econometric methods”. McGraw-Hill.
Keynes, J. (1971) “A Tract on Monetary Reform”, London and New York: Macmillan and Saint Martin’s Press, 1923.
Lastrapes, W. (1992) “Sources of fluctuations in real and nominal exchange rates”. Review of Economics and Statistics.
Meese, R and Rogoff, K. (1983) “Empirical Exchange Rate Models of the Seventies: Do They Fit out of Sample”, Journal of International Economics, 14, 3-24.
Meese, R and Rogoff, K. (1988) “Was it real? The exchange rate-interest differential relation over the modern floating-rate period”, The Journal of Finance.
Moreira, A., Fiorencio, A and Lopez H. (1997) “Um modelo para a previsao conjunta do PIB, inflacao e liquidez”, Revista de Econometrica, 17, 67-111.
Mougillianski, G. (1995) “Determinantes del Tipo de Cambio Real de Equilibrio en Perú: 1980-1994”, Documentos de Trabajo Nº4, CEPAL.
Mujica, P. and Crespi, G. (1997) “Determinantes del Tipo de Cambio Real: Un modelo de Vectores Autorregresivos para Chile”. XV Encuentro de la Sociedad Econometrica, mimeo.

Obstfeld, M. and Rogoff, K. (1997) “Foundations of International Macroeconomics”, MIT Press, Cambridge MA.
Pesaran,M., Smith, R. and Yeo, J. (1985) “Testing for structural stability and predictive failure. A review. Manchester School 53.
Pollack, R. and Wales, T. (1991) “The Likelihood Dominance Criterion. A New Approach to Model Selection”, Journal of Econometrics, 47, 227-242.
Quantitative Micro Software (1996) ” E-Views 2.0 User Guide”
Razin, O. and Collins, S. M. (1997) "Real Exchange Rate Misalignments and Growth". International Economic Integration: Public Economics Perspectives, Cambridge University Press.
Reppeto, A. (1992) “Determinantes de Largo Plazo del tipo de cambio real: una aplicación al caso chileno: 1960-1990”, Colección de Estudios CIEPLAN, 36, 67-98.
Sarantis, N. (1994) “The monetary exchange rate model in the long run: an empirical investigation”. Weltwirtschaftliches Archiv.
Sims, C. (1980) “Macroeconomics and Reality”, Econometrica, 48, 1-48.
Wu, D. (1973) “Alternative Tests of Independence between Stochastic Regressors and Disturbances”, Econometrica, 41, 733-750.

[1] Thoroughly discussed in Dornbush (1992).
[2] See Meese and Rogoff (1983), Cambell and Clarida (1987), Meese and Rogoff (1988), Edison and Pauls (1993), Clarida and Gali (1994), Sarantis (1994), Cushman, Lee and Thorgeirsson (1995).
[3] See Huizanga (1987), Baxter (1994), Clarida and Gali (1994).
[4] See Lastrapes (1992), and Evans and Lothian (1993).
[5] Edwards (1989) and Reppeto (1992).
[6] In a beginning, since we’ll use several test in our search for the greatest possible parsimony, doing away with variables with low explicative power.
[7] See Engle, Hendry and Richard (1983) and Geweke (1984).
[8] An interesting discussion of the different concepts of exogeneity can be found in Darnell (1994).
[9] In words of Harvey (1981): “The explanatory variables may be treated as though they are fixed in repeated samples, even though they may be generated by a stochastic mechanism in the same way as y_t. If this condition is satisfied, the explanatory variables are said to be weakly exogenous”.
[10] That could be treated as exogenous if we accepted the lack of temporal lead of the RER with a probability of error greater than 25%.
[11] To analyze the problem of sub-identification in VAR models see Enders (1995), Hamilton (1994) or Carrera, Féliz and Panigo (1998) for and application to the case of Argentina.
[12] The result of the Augmented Dickey-Füller tests (see Dickey and Fuller (1979, 1980), or Charemza and Deadman (1992)) for the variables in levels and differences (in case of rejection of the hypothesis of integration of first order) for the optimal number of lags determined by Akaike’s criterion (developed by Akaike, 1973) can be obtained from the authors on request.
[13] This confirms the results from section 4.2: to reject the existence of stationarity in mean of the RER.
[14] See Moreira, Fiorencio and Lopez (1997).
[15] A formal analysis of the LRT can be found in Hamilton (1994), while a more intuitive vision is detailed in Darnell (1994).
[16] The use of the Likelihood Ratio Test for this kind of hypothesis is restricted to the fact that the most parsimonious models that is compared with the unrestricted initial model be nested, that is that the variables included in the restricted model are also included in the unrestricted one. For example, with this methodology we can compare the explicative power and the parsimony of a model that includes the variables X, Y and Z in relationship with another one that only contains X and Y. However, we cannot compare one that includes X and Y with another that includes X and Z. For this kind of comparisons (between non nested models) we must use the tests derived from the “Ordering Dominance Criterion” such as the Likelihood Dominance Criterion of Pollack and Wales (1991) that are clearly presented in Amissano and Gianninni (1997).
[17] Its procedure is described in Granger (1983), Granger and Weis (1983), Granger and Engle (1985), that was generalized for a finite number of vectors of cointegration in Johansen (1988).
[18] Ver Quantitative Micro Software (1996).
[19] Which can be obtained from the authors on request.
[20] The results from this test can be sent by the authors on request.
[21] Akaike’s criterion as well as Schwarz’s are lose functions to be minimized that weights the degrees of freedom and the explicative power together. The main difference between them stands in the weighting factor for each argument. Thus, knowing that Schwarz’s criterion penalizes more severely the lose of degrees of freedom, the different results found are not startling. For a more detailed analysis see Hamilton (1994).
[22] For lack of space, the normality, autocorrelation and heterocedasticity tests for each of the variables in the VECM have not been included in presentation, but they can be sent by the authors on request.

[23] From the most parsimonious expression that was found to be adequate to the joint distribution function for the variables included in the marginal block.
[24] The standard deviation in a series of deviations with respect to equilibrium is 26% against 38% in the case of moving averages.
[25] For a detailed review of these issue see Pesaran, Smith and Yeo (1985).
[26] See Brown, Durbin and Evans (1975).
[27] See Johnston (1984) and Harvey (1990)
[28] For further details see Hamilton (1994) or Enders (1995).
[29] In our case there is not a restricted version of the model and besides the recursive estimation used to analyses the parameter stability violates the constant sample condition of LRT.
[30] We choose rolling instead of recursive estimation because the first methodology keeps constant the weight of each observation in the sample, improving the detection of structural breaks in the data. For further details on recursive estimation see Hendry and Ericsson (1991).
[31] For example, the first value for the ERER is just the first value of the first rolling VECM (RVECM), whose sample period is 82:1 - 93:1. The second one is the average of the second value of the first RVECM and the first value of the second RVECM, whose sample period is 82:2 - 93:2...Finally, the last value of the ERER is just the last value of the last RVECM (86:4 – 97:4).
[32] See, Carrera, Féliz and Panigo (1998). In this case the rolling correlation coefficient was calculated fixing the sample size for calculation to 5 years or 20 quarters.
[33] We present an estimation of the PPP real exchange rate to proceed with the comparison only. As we stated previously in the paper the PPP hypothesis does not seem valid for Argentina, at least in the time period of our study.
[34] We took as period of reference for the calculation the equilibrium in the period 85-86. Buscaglia (1997) presents an estimation of the GDP at international parity in US$ where he fully justifies taking 1986 as base year for the comparison.
[35] In their version based on a General VECM for the whole sample as well as in the rolling VECM (both in its HP variant)
[36] See CACES (1998).
[37] With respect to this last factor, the important deterioration of the terms of trade in 1997-98, which most observers see as permanent, indicates that the equilibrium RER is depreciating, even with negative inflation rates in Argentina. In other words, in the light of strong reductions in the terms of trade, to keep the ERER from falling Argentina should produce important increases in its relative productivity or in the demand for real money balances. Besides of what is happening with the equilibrium RER, with a system of fixed exchange rate great nominal flexibility in wages and prices is need to modify the actual RER.